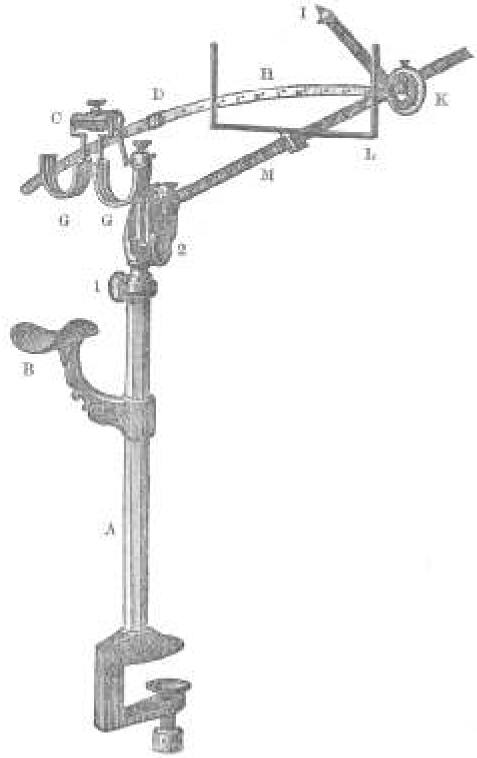
ART. XIX.—*A new Optometer for Measuring the Anomalies of Refraction and the Field of Vision.* By S. D. RISLEY, M.D., Chief of the Dispensary for Eye Diseases at the Hospital of the University of Pennsylvania. (With four wood-cuts.)

THE anomalies of refraction and the disturbances of accommodation and convergence depending upon them furnish a very important chapter to the ophthalmologist. A very large proportion of the annoyances or positive and severe suffering, from which patients seek relief, grow directly from certain anatomical departures from the normal eyeball, which disturb the proper relation between the refracting apparatus and the perceptive layer of the retina. These conditions may be present in very slight degrees, causing but little if any annoyance, or so great may be the defect as to render comfortable or accurate vision impossible.

The selection of glasses which shall correct these optical defects becomes then a matter of the first importance, and demands at the hands of the oculist a careful determination of the existing refractive condition of the eye. To accomplish this end, much time and patience are required, even with the aid of the best appliances. In the more frequently occurring defects, as *myopia* and *hypermetropia*, the problem is comparatively a simple one. Then, too, in these an approximate correction will often prove all that is necessary; but when these conditions are associated with astigmatism, or when the latter alone is present, the problem becomes more difficult of solution. In astigmatism nothing less than a full correction promises, with any certainty, relief from its annoying or painful consequences. Numerous methods have been devised to give increased facility, and to insure accuracy in determining the degree of this anomaly, and have been employed wholly or in part by ophthalmologists in their daily routine of practice. Necessarily these have been only variations and more or less convenient applications of certain well-known principles. The method most used in this country, is the one devised by Dr. Green, of St. Louis, Mo. (vide *American Journal of the Medical Sciences*, Jan. 1867). It would seem, indeed, that, as a series of test objects for indicating the influence exerted by the astigmatic eye over parallel rays of light, nothing further is to be desired.

In order to facilitate the ready and accurate application of the various methods in use, I have devised the optometer, described in the following pages, and after a year of constant use of it, I recommend it without hesitation to others labouring in the same field. No new principle is involved in the apparatus, but, in its present form and convenient adaptation of various methods and test objects, I believe it to be unique. As seen in Fig. 1, it consists of a stand A, twelve inches high, which clamps by a capstan screw firmly to the table.[1] To this is attached a movable chin rest B, a pair of graduated semicircles C, with their concavity upward for the reception of trial glasses, stenopaic slit, etc., a graduated triangular bar M, 20″ long, supporting a carrier L, which moves freely throughout its length, and a perimeter H, which may be adjusted and removed at pleasure.

Fig. 1.



A. Stand. B. Chin rest. C. Holders for test glasses, etc. M. Carrier bar. L. Carrier. H. Perimeter. I. Fixation point. D. Slide. K. Perimeter head and graduated scale. G G. Semicircles showing three grooves for glasses, etc. 1 and 2. Milled head screws.

The stand is a hollow cylinder admitting a brass rod which moves up and down within it freely, thus extending the height of the stand to eighteen inches. It can be fixed at any point by the screw (1). To this rod is firmly secured a brass quadrant, to the upper anterior part of which is attached the bar M. The quadrant moves on a pivot throughout its extent, so that it gives to the bar M a downward movement through 45°. It may be arrested at any desired point by the milled-head screw (2). To the posterior part of the quadrant is attached the holders C. These are so constructed as to permit the most varied adjustment in order to centre the glasses before the eyes, or they may be removed entirely, which is required when the perimeter, hereafter described, is in use. In the concavity of the semicircles there are three grooves for the reception of glasses, etc., and both their anterior and posterior surfaces are graduated in degrees corresponding to the Nachet test frames. One or more glasses may be placed in the semicircles at the same time, and the distance at which they are centred read off on the holders, at C.[1] The cylindrical lenses can be readily rotated, and the direction of the axis read off on the frame. The bar M is graduated in fractions of an inch commencing with the posterior surface of the holders. The carrier moving upon it is designed to bear a series of cards containing the test-types of Snellen and of Jaeger, and numerous other test figures. Also an opaque carrier plate with a circular opening in its centre two and a half inches in diameter, the lower half of which is graduated in degrees to correspond to that upon the semicircles. Behind the circular opening fits a piece of ground glass, which, when turned toward the light gives an illuminated background. The plate is designed to receive and permit the free rotation of a number of thin brass disks with test figures cut in them.

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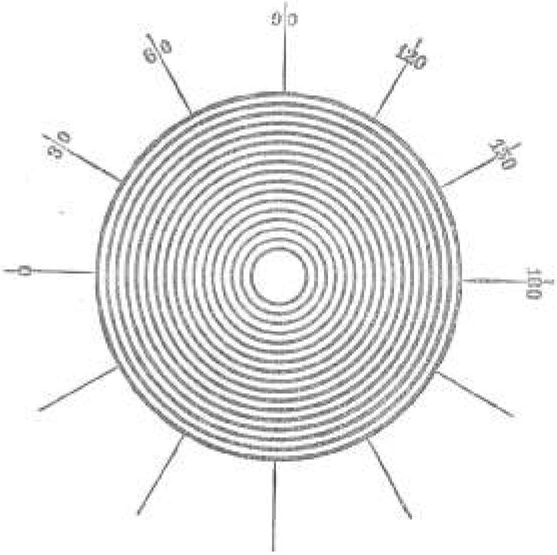
[1] When desired a stand in place of the clamp is furnished.

Fig. 2.



The tests for astigmatism recommended for use in this instrument include the valuable series of Dr. Green[2] (the printed figures and those intended for back illumination are reduced for use at 12″ instead of 20′, as originally designed); the concentric circles of Otto Becker, also reduced for 12″ (Fig. 2); a cross of wires, perhaps the most valuable of the entire series, consisting of a rim of brass, with milled edge to facilitate its rotation in the carrier plate, with two groups of five wires each, stretched 1 mm. apart, crossing the centre at right angles. Another valuable test is furnished by a metal disk with lines cut through it, as shown in Fig. 3, for back illumination. Where there is much diminution of acuity of vision I have found this disk a valuable aid. A metal disk, with central perforation, intended to furnish a bright point of light, will also be found useful. These disks are each $2\frac{3}{4}$″ in diameter, and their distance from the eye is read off on the graduated bar. To the holders are adapted a stenopaic slit and a modification of Thomson's disk, utilizing the experiment of Schreiner. (Vide *Am. Journ. Med. Sci.*, January and October, 1870.) Each has a milled edge to facilitate its rotation in the holders.

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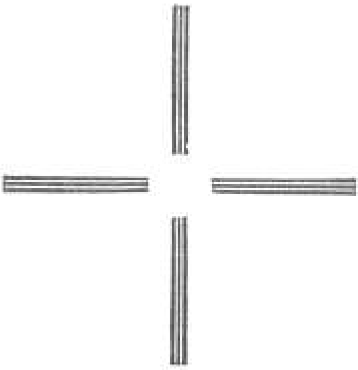
[1] In constructing these holders I am indebted for valuable suggestions to Mr. Samuel L. Fox, of the firm of Queen & Co., Opticians, Philadelphia.

[2] Trans. American Ophthalmological Society, 1869.

Fig. 3.



In using the instrument, one or more of the following methods may be employed quite indifferently as regards their respective merits. Usually it will be found desirable to use more than one method for the purpose of verifying first conclusions. The determinations are all made at an artificial far point—10″ or 12″—and with the eye thoroughly atropinized, when a careful and accurate measurement of the refraction is desired. Without this, except in aged people, there can be no assurance that the result obtained is a correct one, whether the determination be made at 12″ or 20′. Without the use of atropia I prefer to rely upon determinations made with the ophthalmoscope in a moderately darkened room, than upon the most careful trial with glasses. At first I felt some hesitation in relying upon corrections made at 12″, but after I had in numerous cases verified them by repeated, independent determinations at

20′, I gained confidence in this method, and now without hesitation prescribe the correcting glass so determined.

Before using the atropia, the range of accommodation is determined either with the wire cross, point of light, or by the test-letters, and the farthest and nearest point recorded. After paralysis of the accommodation by atropia $+\frac{1}{12}$ is placed in the holders before the eye, and the card containing No. 1 or No. 2 of Jaeger's test-types placed in the carrier, and the distance at which it is read (if it can be read at all) noted. If they cannot be read at any distance (very high degrees of myopia or hypermetropia excluded), one or more of the astigmatic test-cards is dropped before the eye in the carrier to ascertain if the inability to read depends upon the presence of astigmatism. The letters are read, however, but not at 12″, the focal distance of the glass in the holders. If Jaeger No. 1 can be read first, or the wires of the optometer are first distinctly seen, *e. g.*, at 8″, we have myopia $(M) = \frac{1}{8} - \frac{1}{12} = \frac{1}{24}$, and it is found that with a concave 24″ focus glass $(-\frac{1}{24})$ Jaeger No. 1 can now be read at 12″. If, however, the point of distinct vision is found to be, *e. g.*, at 16″ instead of 12″, we have hypermetropia $(H) = \frac{1}{12} - \frac{1}{16} = \frac{1}{48}$. We now find that with a convex glass 48″ focus $(+\frac{1}{48})$ Jaeger No. 1 can be read at 12″. This in simple cases of myopia or hypermetropia is sufficient. It may be verified, however, by the point of light viewed through Thomson's double perforated disk placed in the holders, when the double images seen will be fused by, in the one case $-\frac{1}{24}$, in the other by $+\frac{1}{48}$, if these glasses represent truly the refractive condition of the eye.

Astigmatism being present, its existence and the direction of the principal meridians of curvature will at the same time be detected by placing in the carrier one or more of the numerous test figures, employing either the cut metal disks or the printed figures. The carrier is placed at a point too remote for distinct vision, and one of the test figures being placed in it, is steadily moved toward the eye and the patient desired to indicate which of the diameters of the figure first comes into view. With the printed figures this will be told by some of the lines appearing black and distinct while the others, usually those perpendicular to the first, are still hazy and indistinct. The first line will be perpendicular to the meridian of most favourable corneal curvature. If the concentric circles be used (Fig. 2), the dark or distinct line through the figure will be parallel to the meridian of most favourable curvature. If the cut disks are used, the meridians are selected by the distinctness with which the radiating lines are seen, and the degree read off on the scale below them, attached to the carrier-plate. In the disks containing the radiating lines of perforations or the cross, none of the minute holes are seen as round points of light, but with indistinct outline, which for each individual hole is more or less irregularly oval, the long axis of each pointing in the same general direction. It follows that in some one of the radiating lines, or if it is preferred to rotate the arms of the cross of holes before the eye, it will be found in the direction of some meridian that these oval points of light are ranged side by side, while at the meridian perpendicular to this they are arranged end to end, and if the anomaly be considerable may even be run together so that the holes blend with each other and form a continuous line of light which will be perpendicular to the meridian of most favourable curvature. Having in this manner discovered the principal meridians, it now remains to determine the refraction in each. This may be done in a great variety of ways with the test objects, etc., furnished with the optometer. The following will be found quite sufficient. The wire cross is placed in the carrier beyond the limit of distinct vision, with its groups of wire parallel with the principal meridians. (The meridians may often be best picked out by revolving the cross before the eye.) It is now moved slowly toward the eye. The group of wires which stand perpendicular to the meridian of most favourable curvature will come first into view. The distance at which they are most distinctly seen is now noted, and the distance for the second group sought and noted. The difference between these distances and 12″—the distance at which an emmetropic eye would see them best—gives the defect for each meridian, and their difference the amount of astigmatism; *e. g.*, with $+\frac{1}{12}$ before the eye—principal meridians proved to be vertical and horizontal, vertical wires of the cross seen at 16″, horizontal wires at 12″. By this there is shown to be in the horizontal meridian of the cornea $H = \frac{1}{12} - \frac{1}{16} = \frac{1}{48}$; vertical meridian emmetropic; hence simple hypermetropic astigmatism. In high degrees of hypermetropia it is sometimes desirable to use a stronger glass than $+\frac{1}{12}$, *e. g.*, $+\frac{1}{5}$ or $+\frac{1}{6}$; so that the far point shall not be further than 20″ from the eye—the length of the carrier bar. The same may be done with either of the test figures, but the wires usually are most satisfactory.

The results thus obtained may also be found by one or more of the following expedients:—

Place in the holders the stenopaic slit parallel to one of the meridians, and Jaeger No. 1 at the artificial far point—12″. The glass with which the type can be most easily read is the measure of the refraction for that meridian, and in the same manner the second meridian may be determined; the difference between the two giving the degree of astigmatism. It may be still further verified by means of Thomson's double perforated disk and point of light. The glass which fuses the double images is the measure of the anomaly for any given meridian; indeed this may be used first, and it will be found rarely necessary to depart from results thus obtained. A single case selected from practice will serve to illustrate the foregoing.

L. E., æt. 18, *mixed astigmatism in right eye, myopic astigmatism in left*, $V = \frac{20}{\mathrm{CC}}$ each eye. O. S., $+\frac{1}{12}$ before the eye. Vertical lines were seen at 8″, horizontal at 6″, showing in the horizontal meridian $M = \frac{1}{8} - \frac{1}{12} = \frac{1}{24}$, in the vertical meridian $M = \frac{1}{6} - \frac{1}{12} = \frac{1}{12}$, or $M = \frac{1}{12} - \frac{1}{24}$, and Am $= \frac{1}{24}$. It was then found, that, with stenopaic slit placed before the eye vertically, and test-types at 12″, the weakest glass with which Jaeger No. 2 could be read was $-\frac{1}{12}$; with slit horizontal $-\frac{1}{24}$ was sufficient. The second method thus verified the results of the first. $-\frac{1}{24} \bigcirc -\frac{1}{24}$ cyl. axis horizontal was now placed before the eye, with which Jaeger No. 1 was read without difficulty at 12″.

O. D. answers with astigmatic figures confusing. Cross placed at 16″, wires best seen vertically. Not so distinctly when rotated to right or left. Not so clear nearer or further than 16″. Horizontal wires seen only at $5\frac{1}{2}$″. Thus was shown in the vertical meridian $M = \frac{1}{5.5} - \frac{1}{12} = \frac{1}{10}$, in the horizontal meridian $H = \frac{1}{12} - \frac{1}{16} = \frac{1}{48}$, or Amh, corrected by $-\frac{1}{10}$ cyl. ax. horizontal $\bigcirc + \frac{1}{48}$ cyl. axis vertical ($-\frac{1}{10}$ cyl. $| - + \frac{1}{48}$ cyl.). This result was then verified by the stenopaic slit and trial glasses, and by the point of light.

This point of light, doubled by Thomson's disk, is used at 12″, the double image being fused by the correcting glass, or the point of light may be moved with the carrier back and forth until but one image is seen, which will be at the distance for which the eye is focussed. The difference between this and 12″ is the anomaly of refraction.

The ability to read No. 1 of Jaeger's types with $+\frac{1}{12}$ at 12″, does not necessarily prove that $V = \frac{20}{\text{XX}}$. Many persons with sharpness of vision no greater than $\frac{1}{1}$ are able, even without the increase in size of the image afforded by $+\frac{1}{12}$, to read Jaeger No. 1 at 16″, or in strong light at 18″, or even 20″. Again, even with an imperfect image formed upon the retina, great familiarity with the form of the letters will often make it possible to read Jaeger No. 1, or to name the letters of No. xx of Snellen's types at 20′. So that in relying upon letters or reading alone as a test for the correction of the defects of refraction, there is great liability of being satisfied with only an approximate correction. A far more rigid test is the point of light or the wire cross. When the point of light loses the star-like radiations, and is seen as a round clear-cut hole, or when the individual wires in the cross are sharply seen, with no tendency to doubling or blurring of their edges, the anomaly is, without doubt, corrected.

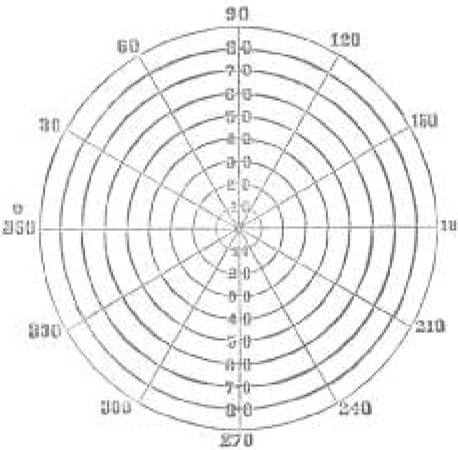
As a test for acuteness of vision, the "*internationale sehproben*" of M. Burckhardt are more reliable than letters. I have found that to count the dots in his series at the required distance is much more difficult than to read the Latin text subtending the same angle.

In determining the degree of muscular insufficiency, the optometer has proved a great convenience. The point of light is placed at 12″, and prisms employed in the usual way, but are used more conveniently, as one or more can be readily placed in the holders at the same time. The point of light is better than the dot and line, or than any ordinary object held in the hand, and avoids the annoyances which attend the use of a wax candle, or other source of light. Insufficiency for distance is determined by directing the gaze to a point of light in the window, furnished by placing over the window-pane a piece of binder's board with a perforation $\frac{1}{4}''$ in diameter in its centre, with white tissue-paper over it.

Inability to converge for an artificial far point has hardly presented itself as an objection, for the reason that the determination has invariably been made for each eye separately; a tendency to diplopia only appearing, when the patient was requested to read at 10″ or 12″ with the correcting glass over both eyes, which was readily remedied, except when marked insufficiency of the internal recti muscles had before existed, by slightly decentering the glasses, which was readily accomplished with the adjustable holders.

A very valuable feature of the instrument is the perimeter H, Fig. 1. It may be adjusted, as seen in the figure, upon the bar M at pleasure, and when not in use removed. When the perimeter is in use, the carrier and holders are to be removed. It consists of a quadrant of a circle, the radius of which is 12″. It is shown at H in Fig. 1. When adjusted, it is placed on the bar M at 12″. The mechanism for adjustment allows the rotation of the quadrant around the bar as a fixed point. In its rotation it moves over a graduated circle at K, in its course describing a hemisphere, the pole of which would be the fixed point upon the axis of rotation. The meridian of the sphere at which the quadrant may be placed is read off on the scale at K. The quadrant is also graduated from the bar out to 90°, and has upon it a slide, D, designed to carry different coloured buttons.

Fig. 4.



The hemisphere and circles described by the perimeter are represented in Fig. 4. The concentric circles serve to show the imaginary lines drawn by the graduations on the quadrant in their course around the bar, represented by the centre of the figure, while the radiating lines are the points at which it has been arrested in its course. Fig. 4 is the blank I use for recording the field of vision. These blanks are furnished with the instrument, either with gummed backs that they may be conveniently pasted in the note-book as desired, or in books of one hundred each with blank numbers for reference to the case-book.[1] The patient is seated before the instrument with the chin-rest so adjusted as to bring the eye to be examined an inch above the bar M, the inferior orbital ridge resting against the support for the holders which have been removed. The point of fixation for the macula lutea is now so arranged that the image of the perimeter head shall fall upon the blind optic nerve entrance. The field of vision in any of the meridians is now ascertained, if desired, for white or red, yellow, green, and blue, by placing these different coloured buttons in the slide and moving it out to the limit of the field; the point at which it is last seen being recorded in a corresponding point on the blank, 0° being to the left, which becomes for the left eye the temple field, but nasal field for the right eye. To discriminate it is only necessary to mark them right and left. The same blank may be used at succeeding consultations, by recording the field with different coloured ink or crayon, and the date at which it was taken in the same colour, in the margin. A map of the field is made by simply drawing an ink line through the limiting mark on the different meridians.

The field of vision can thus be accurately mapped out, and recorded in such a manner as to be rapidly and conveniently studied and compared with former or subsequent records. This apparatus presents the advantages of giving an accurate field with a satisfactory method of recording it, while it is not so cumbersome and unsightly as many of the instruments recommended for this purpose, and when not in use is easily removed and placed out of the way in its case, or it may be left adjusted without serious inconvenience when using the optometer for other purposes.

112 SOUTH SEVENTEENTH STREET, PHILADELPHIA.

ART. XX.—*Enormous Abscess of Kidney cured by Incision and Drainage.* By J. F. HEUSTIS, M.D., of Mobile, Ala.

THE following case is worthy of record on account of its recovery from a condition apparently hopeless; and the immediate and complete relief from great suffering afforded by the operation for evacuation of the pus.

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[1] The complete instrument is furnished by Queen & Co., 924 Chestnut Street, Philadelphia.